



Science and Technology Program – Science Strategy – FY18 Annual Implementation Plan

**Research and Development Office
Science and Technology Program**



**U.S. Department of the Interior
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Introduction

To support progress in addressing the research areas and categories identified in the *Science and Technology Program – Strategic Science Priorities – FY2018-FY2021*, this document identifies the specific research needs for each category that the S&T Program is interested in addressing through solicited and brokered projects during the FY2018 call for proposals.

How are Research Needs and Projects Identified?

Research Roadmaps

- Roadmapping is intensive effort to elicit and illuminate the needs within a research category. Roadmapping may be done within a research area, research category or even some research needs require their own deep dive to discover specific research needs. Roadmapping efforts are sponsored by the S&T Program and involve bureau-wide input. Roadmaps typically take anywhere from 6 months to 1 year to complete.

Regional Director Needs

- Each year, prior to the call for proposals, the S&T Program solicits the Regional Directors for a list of their highest priority research needs in a given year. These needs evolve from year to year and are published in the annual call for proposals.. The S&T Program tried to be responsive to these needs by attempting to develop a combination of solicited and brokered proposals to address them.

Direct Feedback to the S&T Program

- In past years, the S&T Program held a Research Jam to collect research needs from a bureau-wide audience. While this yielded some good ideas from time to time, the S&T Program is evaluating alternatives to replace the Research Jam with something better. In the interim, [a google form](#) has been created to allow research needs to be submitted directly to the S&T Program. These submissions will be reviewed and evaluated to determine the appropriateness of listing them in this document.

Partnerships

- The S&T Program maintains partnerships with a variety of federal, state, and local government agencies, as well as non-profits, universities, and private entities. During coordination opportunities with these partners, collaborative research opportunities are often identified. This allows the S&T Program to share the funding burden of the project and also expand the knowledge base contributing to the project.

Fiscal Year 2018-2021 Science Priorities

The table and narrative descriptions below represent the S&T Program's priority research areas and categories for fiscal year (FY)-2018-2021.

Research Area	Research Category
Water Infrastructure (WI)	<ul style="list-style-type: none"> • Dams • Canals • Pipelines • Miscellaneous Water Infrastructure
Power and Energy (PE)	<ul style="list-style-type: none"> • Hydro Powerplants • Energy Efficiency • Pumping Plants • Non-Hydropower Renewables
Environmental Issues for Water Delivery and Management (EN)	<ul style="list-style-type: none"> • Water Delivery Reliability • Invasive Species • Water Quality • Sediment Management • River Habitat Restoration
Water Operations and Planning (WP)	<ul style="list-style-type: none"> • Water Supply and Streamflow Forecasting • Water Operations Models and Decision Support Systems • Open Data • Climate Change and Variability
Developing Water Supplies (WS)	<ul style="list-style-type: none"> • Advanced Water Treatment • Groundwater Supplies • Agricultural and Municipal Water Supplies • System Water Losses

Cross-cutting research areas

FY 2018 Research Needs

This section outlines short lists of research needs by research area and category.

Water Infrastructure (WI)

Improve the resiliency of Reclamation water storage, water delivery, and facilities by producing or advancing effective solutions, tools, and practices that Reclamation facility managers can use to cost effectively maintain, modernize, and extend the life of Reclamation's aging infrastructure. These should be related to Reclamation's operations and maintenance responsibilities.

Dams

Description: Examine and develop tools, methods, practices, and strategies to improve condition assessment, repair and maintenance, reliability, service life, and safety.

Coordination contacts: Erin Foraker and Bobbi Jo Merten

Source of research needs: [Research Priorities to Enhance Dam Infrastructure Sustainability](#)

Needs Statements:

1. Remote sensing or inspection method to detect seepage or material transport paths (cross cutting with Canals).
2. Methods and materials to detect and fill or repair voids under spillway slabs.
3. Improve gate reliability, including the procedure, need and frequency for gate exercising.
4. Evaluate and verify finite element modeling of existing concrete and embankment dams based on their historical seismic loading for foundations.
5. Methods or tools to characterize the effectiveness of in situ dam foundation repairs (stone columns, compaction grouting, and jet grouting).

Canals

Description: Examine and develop tools, methods, practices, and strategies to improve condition assessment, repair and maintenance, reliability, efficiency, service life, and safety.

Coordination contacts: Erin Foraker and Bobbi Jo Merten

Source of research needs: [Research Priorities to Enhance Canals Infrastructure Sustainability](#)

Needs Statements:

1. Effective canal seepage detection methods or technologies for use by engineers or field staff to more clearly define seepage paths (cross cutting with Dams).
2. Underwater canal panel placement material or method.
3. Non Hazardous tools or methods to control or prevent woody vegetation in canals.

4. Improved, less expensive canal lining, cover, and repair materials and methods.

Pipelines

Description: Examine and develop tools, methods, practices, and strategies to improve condition assessment, repair and maintenance, reliability, efficiency, service life, and safety.

Coordination contacts: Erin Foraker and Bobbi Jo Merten

Source of research needs: [Research Priorities to Enhance Pipeline Infrastructure Sustainability](#)

Needs Statements:

1. Investigate non-metallic pipes for large diameter and high pressure use.
2. Better ROV instrumentation and faster data analysis for evaluating pipe coatings, including film thickness, and pipe body metallic pipe deficiencies, detecting leaks, and faster data analysis.
3. Robotic coating preparation and application.
4. Identify or evaluate cost-effectiveness and constructability of alternatives to pressure grouting for tunnels.
5. Demonstrate low- or no-power tools or sensors for detecting or monitoring metallic corrosion in concrete pipes including prestressed concrete cylinder pipes.

Miscellaneous Infrastructure

Description: Examine and develop tools, methods, practices, and strategies to improve condition assessment, repair and maintenance, reliability, efficiency, service life, and safety.

Coordination contacts: Erin Foraker and Bobbi Jo Merten

Source of research needs: There is not a research roadmap currently available for this category.

Needs Statements:

1. Safety - Identify the potential uses for and safety issues related to driverless vehicles and robots.
2. Security - Develop solutions, tools and practices to further Reclamation's understanding of security risks at its facilities using qualitative and quantitative data. The research should result in data and conclusions that can be integrated into Reclamation's security program to provide Reclamation with an enhanced capability to evaluate and manage risk at its critical infrastructure. For additional details regarding security related research needs, please reference [this document](#).

Power and Energy (PE)

Develop and advance solutions, tools, and practices that improve the reliability, efficiency, and safety of Reclamation's hydropower facilities in order to reduce costs and increase energy supplies. Develop tools and strategies to increase energy supplies through renewable energy development and energy efficient practices and policies within Reclamation pumping plants and

other facilities in support of Reclamation's operations and maintenance responsibilities.

Hydropower Plants

Description: Examine and develop tools, methods, practices and strategies to improve safety, operations and maintenance, reliability, efficiency, outage time, and output.

Coordination contact: Erin Foraker

Source of research needs: For additional details regarding hydropower protection system related research needs, please reference [this document](#).

Needs Statements:

1. Hydropower Generation
 - a. Improves safety and occupational health.
 - b. Increases reliability, power generation, and performance.
 - c. Improves operations and maintenance practices.
2. Protection systems
 - a. Test method improvements
 - b. Less invasive protection system test methods for all aspects of the protection system including current transformers (CT) / potential transformers (PT), protective relays, lockout relays, and associated wires and equipment
 - c. Broad approaches to improvements, which minimize outage periods, reduce Operation and Maintenance (O&M) costs, improve reliability and protection, etc.
 - d. Online monitoring of protection equipment
3. Environmentally friendly lubricants
 - a. Determine the applicability and longevity of greaseless technologies and environmentally friendly lubricants to Reclamation's powerplant operations.

Pumping Plants

Description: Examine and develop tools, methods, practices and strategies to improve safety, operations and maintenance, reliability, efficiency, and outage time.

Coordination contact: Erin Foraker

Source of research needs: [Research Priorities to Enhance Pumping Plant Infrastructure Sustainability](#)

Needs Statements:

1. Buried and Encased Pipe
 - a. Research and develop longer service life interior pipe coatings that can be applied at low temperatures and high humidity
 - b. Review and reassess uses of non corrosive materials, such as polyvinyl chloride, for buried and encased pipe
2. Investigate nondestructive inspection tools, such as ultrasonic testing, to improve efficiency and effectiveness of inspections in hard to access areas
3. Pump Economics

- a. Investigate the economics of repairing versus replacing pumps and pump impellers (the Bureau of Reclamation's [Reclamation] Technical Service Center [TSC] has a pumping plant assets inventory data file)
 - b. Investigate the economics of variable frequency drives with regard to operational parameters, equipment and installation costs, and future utility costs (high power factor)
 - c. Identify and modify machine condition monitoring techniques used for powerplants to be applicable for pumping plants
 - d. Investigate composite materials for intake equipment, such as structural fiberglass, including lifecycle cost and benefit-cost analyses
4. Vibration testing of exposed pipe in pump discharge basins (not in roadmap)

Energy Efficiency

Description: Examine and develop tools, methods, practices and strategies to improve energy efficiency at Reclamation buildings and non-hydropower facilities.

Coordination contact: Erin Foraker

Source of research needs: There is not a research roadmap currently available for this category.

Needs Statements:

1. Explore new technologies and approaches to conduct to improve energy efficiency audits by experts and identify facility specific conservation and efficiency measures.
2. Develop, identify, and educate Reclamation personnel on best practices to achieve facility resilience, including energy and water conservation best practices, zero energy and zero water buildings.
3. Develop a methodology to maximize energy efficiency improvements prior to solar PV installations.

Non-Hydropower Renewable Energy

Description: Examine and develop tools, practices, and strategies for generating and using non-hydro renewable energy within Reclamation including solar, wind, geothermal, and other forms of non-hydro renewable energy.

Coordination contact: Erin Foraker

Source of research needs: There is not a research roadmap currently available for this category.

Needs Statements:

1. Identify and develop facility scale solar training strategies to facilitate the use of solar PV at Reclamation facilities where feasible.
2. Develop expert resources to perform renewable energy assessments and assist with RFPs related to solar PV at Reclamation's facilities.

Environmental Issues for Water Delivery and Management (EN)

Improve the reliability of Reclamation water deliveries by producing effective solutions, tools, and practices that Reclamation water managers can use to address state and federal environmental compliance and court orders.

Water Delivery Reliability

Description: Improve the reliability of Reclamation water supplies by finding innovative means to address aquatic and terrestrial ecosystem and species needs while still meeting water delivery contracts.

Coordination contact: Connie Svoboda

Source of research needs: There is not a research roadmap currently available for this category.

Needs Statements:

1. Improve understanding of how to implement adaptive management operations to support environmental restoration
2. Develop methods to release flow to establish riparian ecosystems
3. Develop methods to accomplish minimum or seasonal flow releases to benefit fish and wildlife habitat
4. Develop best practices to quantify ecosystem services related to environmental flows
5. Improve understanding of water operations impacts to flow hydrographs and water dependent ecological resiliencies

Invasive Species

Description: Develop and improve techniques for detecting and managing aquatic and riparian invasive species that consume Reclamation water supplies or impede Reclamation water deliveries, or harm threatened or endangered species.

Coordination contact: Denise Hosler

Source of research needs: [DOI: Safeguarding America's Lands and Waters From Invasive Species](#)

Needs Statements:

1. Determine effective detection and monitoring methods in order to identify invasive species infestation and range expansion.
2. Define invasive species habitat suitability requirements and parameters to predict potential vulnerable sites and infestation distributions.
3. Determine effective site-specific uses of existing and innovative integrated pest management (IPM) utilizing chemical, biological, mechanical, and environmental control methods, as well as prevention and suppression of invasive species proliferation without harming non-target species.

4. Determine impacts of invasive species and mitigation measures to protect site specific threatened or endangered species, infrastructure, or operations.

Water Quality

Description: Develop and advance tools and practices that Reclamation has the mission responsibility and authority to use in managing water quality issues that are (1) linked to reclamation operations and (2) could impact the reliability of Reclamation water deliveries if not addressed.

Coordination contacts: Mike Horn

Source of research needs: There is not a research roadmap currently available for this category.

Needs Statements:

1. Improve understanding of operation effects on salinity, temperatures, oxygen, turbidity and nutrient levels in flow releases, and on in reservoir processes
2. Develop methods to predict, manage, and monitor effects of hydrologic and climatic variability on water quality characteristics

Sediment Management

Description: Develop and improve sediment management solutions and tools that improve the reliability and sustainability of water deliveries from Reclamation reservoirs and associated river systems, and improve habitat conditions for threatened and endangered species.

Coordination contact: Sean Kimbrel

Source of research needs: There is not a research roadmap currently available for this category.

Needs Statements:

1. Develop monitoring methods to track sediment released from reservoirs and associated impacts
2. Improve understanding of how sediment transport interacts with channel morphology to create topographic complexity important for habitat, and its application to sediment augmentation
3. Develop indirect methods (e.g. watershed and sediment yield models) to estimate reservoir sedimentation (incorporate prize challenge outcomes where possible)
4. Develop solutions for managing sediment transport and deposition associated with dam removal or reservoir sluicing

River Habitat Rehabilitation

Description: Develop and improve aquatic habitat management solutions and tools that improve the ability to comply with regulatory requirements or mitigation measures assigned to Reclamation programs including channel improvements, floodplain connectivity, channel complexity, and riparian vegetation enhancement.

Coordination contact: Jennifer Bountry

Source of research needs: There is not a research roadmap currently available for this category.

Needs Statements:

1. Study alternatives that eliminate need for fish screens (e.g. infiltration galleries, non-physical barriers)
2. Develop innovative passage improvements and alternatives for threatened and endangered species (incorporate prize challenge outcomes for downstream passage at high dams if applicable)
3. Develop ecosystem health indicators (including connectivity)
4. Identify metrics of habitat and design feature performance for rehabilitation projects
5. Improve methods for quantifying instream habitat for aquatic species
6. Improve methods to predict future channel change in habitat rehabilitation projects and near Reclamation infrastructure

Water Operations and Planning (WP)

Develop solutions and tools that help Reclamation water managers make effective reservoir and river system operational and planning decisions. Improve the integration, evaluation, understanding, and presentation of critical data and information.

Water Supply and Streamflow Forecasting

Description: Develop and improve solutions and tools to forecast and monitor water supplies, including hydrologic events, and water demands.

Coordination contact: Ken Nowak

Source of research needs: [Short Term Water Management Decisions](#)

Needs Statements:

1. Investigate new technologies and methods to enhance basin hydrologic condition monitoring data.
2. Develop techniques to extend or improve skill of temperature and precipitation forecasts to the sub-seasonal time frame, with particular emphasis on wet/dry extreme events.
3. Develop techniques and workflows to automate data acquisition and usage in response to increasing forecast frequency and decreasing latency.

Water Operations Models and Decision Support Systems

Description: Develop and improve reservoir/river system operations and planning models and decision support systems in order to optimally manage water delivery and use for Reclamation.

Coordination contact: Ken Nowak

Source of research needs: There is not a research roadmap currently available for this category.

Needs Statements:

1. Develop approaches and tools to support and improve long term planning for changing or uncertain future hydrologic conditions.
2. Demonstrate the application of new or improved data with existing models toward enhanced operational outcomes.
3. Explore and develop opportunities for decisions support tools that leverage or pair with ensemble forecast products.
4. Explore opportunities for improved planning and operations that can leverage increasing accessibility to high performance computing resources.

Open Data

Description: Develop methods and tools to improve management of Reclamation’s water and related data to make it more comparable across locations, more easily found, and more shareable within Reclamation, and with other agencies, stakeholders, and the public. Proposing teams should familiarize themselves with technical issues identified by the Reclamation Open Data Team, and propose projects that complement [recently completed and ongoing work](#) under this category.

Coordination contact: Levi Brekke

Source of research needs: There is not a research roadmap currently available for this category.

Needs Statements:

1. Develop Reclamation-wide common data standards (i.e. data dictionaries, data models, database schemas) for various Reclamation data types. These data types should be additional to those where [schema development has occurred or is planned](#), and may be related to any of the the following: water and power management, environmental compliance, safety, administrative activities, etc. The produced standards could be adopted locally or Reclamation-wide, and must be compatible with the public-facing RWIS/RISE systems.
2. Identify effective data resource management frameworks and policies in other organizations and evaluate for applicability and effectiveness in supporting the Reclamation Data Council’s potential development of associated frameworks and policies.
3. Demonstrate RWIS utility in novel decision-support applications, in applications to enhance existing water operations decision-support tools (e.g., Riverware, WRIMS, Excel operations models), or through integrations with information systems of other agencies (e.g., USGS, USACE).
4. Develop and demonstrate visualization tools that leverage RWIS data to better support engagement, communication, and collaboration amongst Reclamation customers, stakeholders, and the general public.
5. Recognizing advances and trends in data search and usage (e.g. web 3.0, semantic web, etc) that leverage enhanced metadata and learning algorithms, identify and evaluate such

technologies for applicability and effectiveness in Reclamation information management; how can Reclamation prepare so as to take advantage in a timely manner?

Climate Change and Variability

Description: Develop methods and tools to increase adaptive management and flexibility in the planning, design and operations of Reclamation's facilities in a variable and changing climate, including management through drought and floods.

Coordination contact: Ken Nowak

Source of research needs: [Addressing Climate Change in Long Term Water Resources Planning and Management](#)

Needs Statements:

1. Develop tools and resources to support informed use of climate data in water management applications.
2. Develop methods for communicating results and uncertainties to decision makers.
3. Identify risks posed by climate change to efficient and continuous operation of water and power infrastructure, and potential adaptation strategies.
4. Understand how climate data are being incorporated into Reclamation water management and planning efforts and develop case study examples as references, where appropriate.

Developing Water Supplies (WS)

Develop, enhance, and protect water supplies for Reclamation stakeholders with new technologies, solutions, and practices that expand, liberate, or conserve water supplies.

Advanced Water Treatment

Description: Develop technologies, methods, tools and approaches to advance the treatment of impaired water sources that allow Reclamation to better utilize existing supplies, increase existing Reclamation supplies through augmentation, or prolong existing Reclamation supplies by expanding or developing non-traditional supplies from an outside source such as impaired groundwater or surface water.

Coordination contact: Yuliana Porras Mendoza

Source of research needs: [Desalination: A National Perspective](#) and [Water Reuse: Potential for Expanding the Nation's Water Supply Through Reuse of Municipal Wastewater](#)

Needs Statements:

1. Develop tools and models to support reduced costs of water treatment by making improvements to Reclamation's Water Cost Model, identifying triple bottom line treatment costs, and modeling the true cost of water treatment.
2. Enhance water management decision making by quantifying the non-monetized costs and

benefits of potable and non-potable water reuse compared with other water supply sources.

3. Reducing the environmental impact of water treatment by:
 - a. Reducing chemical usage
 - b. Mitigating biofouling
 - c. Improving Concentrate management
4. Develop improved techniques and data to consider hazardous events or system failures in risk assessment of water reuse.
5. Develop innovative new water treatment systems (membranes, systems, processes, etc) for treatment of impaired water for various uses (potable, industrial, storage, municipal, agricultural, etc).
6. Develop models for implementation and management of various water sources in need of one or more treatment for one or more end use.
7. Develop innovative new materials, membranes, and/or systems and processes for treatment of impaired water.
8. Development of water-energy nexus research in the following areas:
 - a. Coupling of renewable energy sources with water treatment processes.
 - b. Modeling of energy efficiency for innovative new water treatment processes or combination of existing water treatment processes.
 - c. Treatment and use of produced/fracking water for increase in water supply and energy production.

Groundwater Supplies

Description: Develop and improve solutions and tools that advance and optimize groundwater storage and conjunctive groundwater/surface water storage and use for Reclamation projects.

Coordination contacts: Jennifer Johnson and Ken Nowak

Source of research needs: [Brackish Groundwater in the United States](#) and [Ongoing Research Needs: Groundwater-Surface Water Interaction](#)

Needs Statements:

1. Groundwater quality data needs
 - a. Occurrence and Distribution of Groundwater
 - b. Hydrogeologic Characterization
 - c. Geochemistry
 - d. Brackish Groundwater Use
 - e. Brackish Groundwater Sustainability
2. Groundwater-surface water interaction
 - a. Summarize relevant data and overcoming data gaps.
 - b. Models and processes used to evaluate groundwater-surface water interaction in regulated river systems.

Agricultural and Municipal Water Supplies

Description: Develop and improve solutions and tools that automate, measure, and deliver agricultural water resulting in liberated water or a cost savings for Reclamation or its stakeholders.

Coordination contact: John Whitley

Source of research needs: There is not a research roadmap currently available for this category.

Needs Statements:

1. There are currently no specific research needs for this category.

System Water Losses

Description: Develop and improve solutions and tools that conserve water and/or reduce water losses, in Reclamation water storage and delivery systems.

Coordination contact: Yuliana Porras Mendoza

Source of research needs: There is not a research roadmap currently available for this category.

Needs Statements:

1. Improve evaporation measurement technology that is necessary to evaluate the efficacy of evaporation suppression technologies.
2. Improve evaporation measurement data management at Reclamation reservoirs and evaluate the impact of the sustained water loss.